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Implementation of California's Troubled Zero Emissions Vehicle Mandate: A Review of Push-Pull Theory and Existing Circumstances

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ABSTRACT

California's 2035 Electric Vehicle Mandate essentially required that all new vehicle sales must be all-electric. Subsidy funding from California for consumers was generally limited and came from cap-and-trade revenue allocations. California's process is what business management scholars characterize as a "Push" strategy. For California this manifested as: 1.) put even more taxes or cap-and-trade revenue dollars against the effort and, 2.) "push" even more with legislated mandates. The lingering overarching questions continuing to this day consider if this approach is working and, if not, should another approach be considered? The authors' intent is to project in the simplest terms whether California's current path will meet their stated goals. As a natural extension of this analysis, California's "Push" strategy will likely not achieve the success, and should they consider another management strategy? Evidence was gathered, as much as practicable, using the state of California's own data and other sources related to consumer buying habits for the various demographic consumer groups identified. Simple projections made in Excel over the mandates time-period, ending in 2035, looked to see what the economic implications would be for the various demographic groups and how that would logically affect their participation and therefore mandate goals' success. The main findings strongly suggest that the lower economic demographic that makes up approximately 40% of the population have been and will continue to be resistant to participate in EV purchases. In addition, insufficient infrastructure (i.e. enough chargers and in the right locations) is an impediment to all demographic groups. The costs to meet the mandate both practically and economically are too high for California to get the participation rates needed to meet its' mandate goals. The "Push" management strategy employed by California is not likely to result in mandate goals being met. The authors believe California should pivot to a "Pull" management strategy which addresses the political, cultural, scientific, economic, and industrial concerns of all demographic groups.

Keywords: Climate change; Zero-emission; Battery electric vehicles (BEVs); Hybrid electric vehicles (HEVs); Plug-in hybrid electric vehicles (PHEVs); Push-pull theory

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1. INTRODUCTION

This paper is focused solely on California's difficulty in implementing its original 2035 zero emission mandate (the Original Mandate), pursuant to an executive order (EO), that all sales of brand-new vehicles must be zero emission (primary focus being all-electric) by 2035, now extended to 2045, and recent federal legislative actions which may effectively impede its enforcement.

Acting upon congressional approval that occurred on 12 May 2025 (Lazo and Reyes Velarde, 2025), which included bipartisan support in the House, President Donald Trump signed three measures on June 12 that block California's mandates to phase out gasoline-powered vehicles and clean up diesel-powered trucks by 2025 (Lazo and Reyes Velarde, 2025). "Congress used the Congressional Review Act to revoke three waivers granted by the Biden administration to California to gradually eliminate gasoline powered cars and diesel trucks. Trump's signing made that official" (CalMatters Staff, 2025, para. 4). California quickly filed a lawsuit to counter Trump's actions. Ten other states joined the lawsuit. Governor Newsom also directed the California Air Resources Board to draft a new mandate (CalMatters Staff, 2025).

The apparent motivation by Trump involves an allegation that California's clean vehicle, emission standards, and Battery Electric Vehicle's (BEV) 2035 Original Mandate affects national new vehicle production and related consumer choice. "We officially rescue the U.S. auto industry from destruction by terminating California's electric vehicle mandate," Trump said at the White House. "And they're never coming back" (CalMatters Staff, 2025, para. 3). He said the state's zero-emission car "phase-in" has been a disaster for this country (CalMatters Staff, 2025, para. 3). Of critical note is the extremely fluid nature of not only California's EV policies and any future related details surrounding them, but California's overall "green energy" policies as well. Data and policy analyses in this paper are primarily based on events and circumstances through 31 August 2025, with minimal mention of the very recent EV mandate extension to 2045, which has scant information and details presently.

Predicting the outcomes of the various related lawsuits is difficult as multiple factors of a legal nature are in-play. Of issue is the age-old premise of states' rights versus federal control. It is unknown at this time if federal revocation of vehicle emissions waivers, which previously allowed states such as California, to enact more strict standards than federal ones, will prevail throughout the court system. As is the case with many of Trump's actions, lower courts may rule against his actions, but appeal courts and the Supreme Court may uphold them. What could impede this countersuit by Newsom is the fact that the US Congress, on a bi-partisan basis, approved legislation to block the waivers granted administratively by the Biden Administration, and Trump merely signed the legislation versus issuing an executive order. Typically, legislation overrides executive orders. Because of this, despite recognition of a future unknown outcome, these authors tend to believe the Newsom suit will fail, and the waivers' revocation will prevail.

While the current BEV supply and demand environment, consumer range anxiety, including charging stations' infrastructure, and the aforementioned political landscape certainly present significant obstacles to any future EO or legislation revisiting such Original Mandate, these authors provide data/information relative to underlying issues that may influence such efforts. In particular, Push-Pull Theory was examined as a means for California to transition from a Push policy (the Original Mandate) to a Pull strategy, recognizing consumer concerns, which could involve more emphasis on building an adequate charging station infrastructure and addressing other factors that affect "range anxiety."

2. RESEARCH METHODOLOGY, QUESTIONS, AND PROPOSITIONS

The scholarly contribution of this article involves an original empirical analysis obtained from information in secondary data and a literature review. Data was gathered as much as practicable using the state of California's own data. This was enhanced from other sources related to consumer buying habits for the various demographic groups concerned. Simple projections made in Excel covering the mandate's time period, ending in 2035, looked to see what the economic implications would be for the various demographic groups and how that would logically affect their participation and therefore the mandate goals' success.

Using search engines from the Pfau Library at California State University San Bernardino, and Google Scholar, forty-six (46) references were obtained which were pertinent to this research endeavor.

Of that magnitude, forty-one (41) sources ranged from 2023 to 2025, because the focus of this research paper was on current data in a highly fluid environment. As such, thirty-one (31) of those forty-one (41) sources were from government and automobile association websites, including such organizations and associations like Cal Matters, the California Air Resources Board, and the California Department of Energy. Academic peer-reviewed sources are minimal regarding recent electric vehicle sales data and applicable government policy actions, hence the importance of this article. However, there were ten (10) academic sources of the forty-one (41) recent sources that were published in journals and included references in such sites as Science Direct, MDPI, and Emerald Publishing. Of the five (5) sources older than 2023, one academic source concerning range anxiety dated to 2009 and was included in the journal, Transportation Research and indexed in Science Direct; three sources ranged from 1966 to 2012, which addressed Push-Pull Theory and involved two books and one journal article from Transportation Research, referenced in Science Direct; and one source from 2022 involved electric vehicle affordability and was written by authors from the aforementioned Cal Matters.

Considering recent California legislative actions in consort with changes in federal policy regarding waivers for California's more restrictive vehicle emissions standards, one may question why market and range anxiety analyses are even applicable. These authors suggest that, while not precisely known as to the motivation for California's legislative and federal policy actions, the backdrop for lessening market acceptance of EVs and consumer range anxiety would generally influence legislative actions.

The research questions guiding this study are:

1. Does an analysis of current data and trends suggest California will be able to achieve 100% compliance with the "Original Mandate" for brand new zero emissions auto sales by 2035?
2. Based on current trends and ancillary data, will California have sufficient charging stations to facilitate the desired purchase demand for brand new zero emissions BEVs?

3. RESULTS AND DISCUSSIONS

3.1 California Policies and Issues

The zero-emission vehicle requirement, which was to occur by 2035, was part of the Advanced Clean Cars Regulations (CARB, 2025a), meaning all new passenger cars, trucks, and SUVs sold in California must be zero-emission vehicles (generally all-electric with 20% Plug-in Hybrid Vehicles or PHEVs). Despite this mandate, gasoline cars could have been driven in California after 2035, provided they were registered with the California Department of Motor Vehicles and sold as a used car to a new owner (CARB, 2025b).

Programs enacted by California to facilitate and encourage conversion to clean energy vehicles include(ed):

1. Cap-and-trade (the primary funding mechanism) – 40% in discretionary allocations.
2. Clean Cars 4 All
3. Clean Vehicle Rebate Project
4. Clean Vehicles Assistance Program

Success of these programs in reducing greenhouse gases (GHGs) is apparently unknown or unquantified because the California Air Resources Board has failed to adequately measure it, according to an audit by the state's Legislative Analyst's Office (2024). Presently, the only programs remaining are Cap-and-Trade and Clean Cars 4 All, which have been combined with the previous Clean Vehicle Rebate Project (CARB, 2025a). Criteria for participation in the new combined program for all-electric vehicle purchases only (no hybrids) up to eight (8) years old, assuming such program and related criteria extend beyond 31 August 2025, or will be embodied in any new programs, include:

- $10,000 purchase assistance subsidy and $2,000 charging station subsidy (or pre-loaded charge card) for buyers with incomes less than or equal to 300% of the Federal Poverty Level.
- $12,000 purchase assistance subsidy and $2,000 charging station subsidy (or pre-loaded charge card) for buyers who reside in disadvantaged communities with incomes less than or equal to 300% of the Federal Poverty Level.

Because demand for electric vehicles among disadvantaged communities is negligible at best, for analysis purposes, these authors will only incorporate 300% of the Federal Poverty Level category, absent the disadvantaged community category.

While the Mandate appears in jeopardy, in light of federal actions, such action does not prevent the State from adhering to the Clean-Cars 4-All program or aspects of it. Incentives for purchasing BEVs or PHEVs may still be utilized. However, of critical note is the absence of independent incentives for turning in or scrapping an older vehicle and purchasing a hybrid, PHEV, or BEV (collectively, the term EV will be used forthwith) vehicle. One must do both. Presumably, the individual will be able to turn-in the gas guzzling vehicle and purchase the clean energy one at the same time, but that is unclear. If there is a gap between these events, this could leave the consumer without a replacement vehicle for an undetermined length of time. Data after 30 November 2023, relative to the new combined program, is largely unavailable, likely due to administrative issues/delays and communication to the public (CARB, 2025a).

Regarding annual income qualifications relative to 300% of the federal poverty level for 2025 (roughly at $15,000 per person), that equates to $46,950 for a single person household, $63,450 for two persons, $79,950 for three persons, and $96,450 for four persons (HealthCare.gov, n.d.). For purposes of this paper, because the Census data categorizes family households as two plus, the income for three persons will be used, rounded down to $75,000 to match Census categories.

Table 1: Federal Poverty Level (FPL)

Family Size	*Amounts*	*300% FPL*
For individuals (single)	$ 15,650	$ 46,950
For a Family of 2	$ 21,150	$ 63,450
For a Family of 3	$ 26,650	$ 79,950
For a Family of 4	$ 32,150	$ 96,450
For a Family of 5	$ 37,650	$ 112,950
For a Family of 6	$ 43,150	$ 129,450
For a Family of 7	$ 48,650	$ 145,950
For a Family of 8	$ 54,150	$ 162,450
For a Family of 9	+ $ 5,500 per Person	+ $ 16,500 per Person

Source: Adapted from Health Care.gov (2025). Note: $79,950 will be rounded down to $75,000 to match census data for use in analysis.

3.1.1 California's Implied Sales Ramp-up to Address the Mandate

Based on data from the California Air Resources Board (CARB, 2022) the following sales expectations for EVs (all technologies) from 2026 to 2035 have been developed. Implied by the "Totals" column are the percent (%) "ramp up" expectations between 2026 and 2035 to meet the "Original Mandate".

Table 2: California Percentage Requirements for New Auto Zero Emission Sales, 2026 through 2035

Year	*BEV 300*	*BEV 400*	*PHEV*	*FCEV*	*Totals*
2026	31.40%	0%	3.30%	0.30%	35.00%
2027	39.40%	0%	3.30%	0.30%	43.00%
2028	45.30%	0%	3.90%	0.30%	49.50%
2029	46.80%	8.00%	3.90%	0.30%	59.00%
2030	48.00%	13.70%	3.90%	2.50%	68.10%
2031	48.00%	21.30%	3.90%	2.80%	76.00%
2032	48.00%	27.30%	3.90%	2.80%	82.00%
2033	48.00%	33.30%	3.90%	2.80%	88.00%

2034	48.00%	38.50%	4.70%	2.80%	94.00%
2035	48.00%	40.00%	9.20%	2.80%	100.00%

Notes:

- BEV 300 = battery electric vehicles with up to 300 miles of charging capacity. This capacity generally supports passenger vehicles and light duty trucks in commuting situations of a more urban nature and is limiting for rural drivers. Most vehicles presently on the market are 300 BEV which appears to limit consumer acceptance due to range Anxiety.
- EV 400 = up to 400 miles charging capacity. This capacity is more useful for rural drivers and larger cars and pickup trucks. It appears automobile makers need to make a transition to more BEV 400 vehicles and less BEV 300's.;
- PHEV =plug-in-hybrid electric vehicles, and
- FCEV = fuel cell electric vehicles
- All percentages in the above Table 2 come directly from CARB (California Air Resources Board), Table II-5, p.7, Public Hearing to Consider Advanced Clean Cars II Regulations, 25 August, 2022). [*Source:* Adapted from CARB, 2022]

The data in the following table 3 is derived fromnew car sales data from the California New Car Dealers Association, which sells approximates 1.8 million vehicles each year based on projected sales for 2025 and historical trends. This is then integrated with the previous table 3 from CARB, page 6 of the 2022 update. It is assumed that total sales will be flat until 2035. Multiplying the annual percentage sales expectations from table 3 by 1.8 million equals the implied yearly EV sales needs (all technologies) to meet the "ramp-up" for the "Original Mandate" (Table 4). If aggregate demand/sales are higher or lower than 1.8 million, the EV sales ramp-up per year (all technologies) will change proportionately.

Table 3: Assumed 1.8 MM New Light Vehicle Sales/Registrations per Year

Year	*Average Sales Estimates per Year*	*%/100 Sales Required to Meet Mandate (per Regulation)*	*BEV and PHEV Sales Needs*
2026	1,800,000	0.35	630,000
2027	1,800,000	0.43	774,000
2028	1,800,000	0.51	918,000
2029	1,800,000	0.59	1,062,000
2030	1,800,000	0.68	1,224,000
Sub-tot			4,608,000
2031	1,800,000	0.76	1,368,000
2032	1,800,000	0.82	1,476,000
2033	1,800,000	0.88	1,584,000
2034	1,800,000	0.94	1,692,000
2035	1,800,000	1	1,800,000
		Total BEV & PHEV Required Sold and Registered by 2035	12,528,000

Sources: Clegern & Young, 2022; California New Car Dealers Association, 2024

Note: Under the CARB ramp-up schedule, targeted New EV sales amount to a cumulative amount of 12,528,000 by 2035. However, it is conceivable, while unlikely, that California consumer demand and purchases of EVs could accelerate significantly in the later years of the schedule, meeting the Original Mandate expectations by 2035. For information purposes only, and not part of the ramp-up schedule, this table does not include an estimated base amount of new EV registrations amounting to 2,450,000 for 2024 and 2025 combined, which equals an overall estimate of 14,978,000 until 2035.

3.1.2 Affordability of Electric Vehicles – Availing Oneself of the Incentives

Given the new financial incentives in California's Clean Cars 4 All Program (incorporates and modifies the previous Clean Vehicle Rebate Project), which exclusively includes households less than or equal to 300% of the federal poverty level, demand by this demographic regarding all-electric vehicles appears to be a challenge to the success of the "Original Mandate". Lopez (2022) discusses affordability, both through data analysis and interviews with some California residents. A California Central Valley coalition of advocacy groups, regarding cleaner air, created an organization named the EV Equity Program. Maria Lopez, the supervisor of the program, stated markups of vehicle prices on electric vehicles add to an already existing issue of affordability. These markups are usually around $15,000. As of 2022, new electric cars cost anywhere from $25,000 to $180,000. Many popular models were sold out with long waiting lists. Zhao (2022) states that 55% of all construction workers in California are Hispanic. Within that ratio, 14% are estimated to be undocumented. Holliman and Collins (2023) assert that the use of public transportation or electric passenger vehicles by those employed in the construction industry presents obstacles, because pickup trucks are the norm for workers in that industry. Fischer (2025) released information detailing new light-duty truck prices (starting price – minimal options), which ranged from a low of $49,995 for a Ford F-150 Lightning to a high of $86,645 for a GMC Hummer EV. Full options add an average of $42,000 to these costs. Clearly, these prices are in the upper-cost strata as noted by Lopez (2022) and serve to further challenge the affordability of EVs by construction workers.

Since no statewide government sponsored data set exists that delineates car sales along demographic lines. Lopez and Yee (2023) performed a data set analysis of new vehicle registrations as maintained by the Department of Motor Vehicles. A summary of their findings states that "Communities with high concentrations of electric cars are affluent, college-educated and at least 75% white and Asian. In contrast, electric cars are almost nonexistent in Black, Latino, low-income and rural communities — revealing the enormous task that California faces electrifying the entire fleet" (Lopez & Yee, 2023).

Consistent with the National Gallup survey, Jones (2024) states, according to Cal Matters' analysis as reported by Lopez and Yee (2023), the primary influence for EV purchases in California is income. In the top ten communities in California for EV ownership, most have median incomes exceeding $200,000 versus the statewide average of $84,000, and common home values in those areas exceed $3 million per Zillow estimates. Conversely, electric cars are nearly non-existent in California's lowest income communities: only 1.4% of cars in Stockton's 95202 are electric, where the median household income is $16,976, and 0.5% in Fresno's 93701, where the median is $25,905. Most are plug-in hybrids, which are less expensive (Lopez & Yee, 2023, para. 21). For purposes of this paper, an approximate 1.4% participation rate for low-income consumers will be assumed within the base amount of EV registrations as of 31 December 2025 (2,450,000 total for all consumers x 1.5% = 36,750). Exploring affordability further, if a household pursues incentives and finances an EV (new or used), they must be able to afford monthly payments. Table 5 provides a commonly accepted maximum monthly car payment amount based on pre-tax income.

Table 4: Estimated monthly car payment based on salary

Annual salary (pre-tax)	*Estimated monthly car payment should not exceed*
$25,000	$208 per month
$50,000	$416 per month
$75,000	$625 per month
$100,000	$833 per month
$125,000	$1,042 per month
$150,000	$1,250 per month

Source: Meyer (2023). Note: Annual household incomes below $25,000 (pre-tax) per year are not considered in the table above.

Affordability is then a function of household income, subsidies (both State and Federal), and the ability to finance a purchase. Comparing demographics with subsidized new EV passenger cars and truck costs provides a window into the possibility of purchase for subsidy qualified lower-income groups in California.

Table 5: Affordability analysis for low-income qualifiers for assistance

California Household Income Level per US Census Data	*Car Payment Affordability (10% of Takehome Income)*	*Estimated Yearly Max Vehicle Payment Expenditure (72 Months at 6.75%) for Top Affordable Car Price **	*Top Affordable Vehicle Price Based on Salary **	*Likelihood of Purchasing New Zero Emission EV Passenger Vehicle Cost with Subsidies*	*Likelihood of Purchasing New Zero Emission EV Light Duty Truck Vehicle Cost with Subsidies*	*Number of Households*	
				New Passenger Vehicle EV Cost (With Subsidies) $17,429	*New Light Duty Truck EV Vehicle Cost (With Subsidies) $38,149*		
				Buy/Might Buy/Not Buy	*Buy/Might Buy/Not Buy*		
Income Level:							
Less than $10,000	$1000.00	$1500.00	$7384.00	Not Buy	Not Buy	657,591	
$10,000 to $14,999	$1500.00	$2244	$11,076	Not Buy	Not Buy	410,994	
$15,000 to $24,999	$2500.00	$3756	$18,459	Not Buy	Not Buy	712,390	
$25,000 to $34,999	$3500.00	$5244	$25,843	Might Buy	Not Buy	739,790	
$35,000 to $49,999	$5000.00	$7500	$36,918	Might Buy	Not Buy	1,123,385	
$50,000 to $74,999	$7500.00	$11,256	$75,000	Might Buy	Might Buy	1,849,475	
						5,493,625	41% of 13,699,816 Households
			Not Buy =	1,780,975 (13% of Total Households)	3,644,150 (27% of Total Households)		
			Might Buy =	3,712,650 (27% of Total Households)	1,849,475 (13% of Total Households)		

Source: F&I Tools, 2025

*Comparing "New Passenger Vehicle EV Costs with Subsidies" (Top Affordable Car Price Based on Salary) provided the Buy/Might Buy/Not Buy determinations shown.

*Comparing "New Light Duty Truck EV Costs with Subsidies" (Top Affordable Car Price Based on Salary) provided the Buy/Might Buy/Not Buy determinations shown. Given current incentives the likelihood these lower socio-economic segments of California households will comply with the "Mandate" seem doubtful.

3.1.3 California Sales and Demand Data

As a general comment, based on sources to follow, California's EV sales are increasing but not at consistent growth levels. Despite affordability statistics for low-income groups, the California Energy Commission (CEC, 2024) recently issued a press release reflecting a glowing and optimistic report concerning zero-emission vehicle sales and progress toward meeting state goals. This department asserts California has met its sales goals two years ahead of schedule. EV cumulative sales as of June 30, 2024 were 1,872,429, but appear to be flattening out at approximately 400,000 per year (CEC, 2024). These authors project 2024 year-end sales to be 2,000,000, and 2025 sales will be 450,000 as noted in discussions to come. Of note is the comment by Lopez and Yee (2023) that no official data set is maintained by California regarding the demographics of purchasers of new EV vehicles. The alleged encouraging information in the Energy Commission's press release does not address the income and related affordability gaps. The information released does not show any breakdowns by income, race, or geographic location.

The following provides some insight into the conflicting views of the current demand environment in California:

1. In mid-2024, the California New Car Dealers Association (2024) reported the growth rate of all electric vehicles in California dropped by 1.2% in the second quarter of 2024.
2. Likewise, the number of electric car registrations decreased from 102,730 in the second quarter of 2023 to 101,443 in the second quarter of 2024 (California New Car Dealers Association, 2024).
3. Sales of electric cars declined for the first time in ten years in the final quarter of 2023, despite surging in the first six months of 2023 (California New Car Dealers Association, 2024).
4. Recorded sales for the fourth quarter 2023 were 89,933, a decline of 10.2% (California New Car Dealers Association, 2024).

Somewhat contrasting the above, a November 10, 2024, report by Anderson (2024) of CARSCOOPS, based on data sourced from Experian Automotive, indicated:

1. Dramatic increases in market share from 2020 to 2023 year-end for all categories (EV, PHEV, and HEV) but fluctuating market share data from the third quarter of 2023 to the third quarter of 2024.
2. Comparison of the third quarter of 2023 to the third quarter 2024 indicates fluctuating data with both slight increases in market share and slight decreases in market share.

Furthermore, as noted by Anderson (2024) and more salient for purposes related to this paper:

1. The average quarterly EV registrations were 111,412 per quarter from the third quarter of 2023 to the third quarter of 2024, or 445,648 registrations per annum.
2. A slight increase in the second quarter registrations of 2024, (116,166), and the third quarter of 2024, (116,179).

Based on the above information and for purposes of this paper, annual growth is expected to be 450,000, assuming no change in demand and purchases by lower-income households.

3.1.4 Likelihood of Meeting the "Original Mandate" – EV Purchases

Comparing EV (all technologies) purchases based on annual new vehicle sales of 1.8 million per year with the implied "ramp up" from CARB (2022) and Clegern and Young (2022), and contrasting that with calculated projected anticipated new vehicle EV (all technologies) registrations between 2026 and 2035 based on Anderson's (2024) findings, results in table 6.

Clearly, 450,000 new vehicle EV registrations each year falls short of the 1.8 million required under the "Mandate" as we have defined it, and the "ramp up" to 4.5 million cumulative new EV sales is less than half of the 12.5 million anticipated by the implied "ramp up" schedule. Considering the estimated 2,450,000 new EV registrations for 2024 and 2025 combined, this amounts to 14,952,000 estimated cumulative registrations by 2035 per the CARB ramp-up and 6,950,000 total registrations per these authors' estimates. The difference remains at an 8,002,800 deficiency.

Table 6: Projected New EV Registrations

Consistent Year on Year Flat Demand					
A	*B*	*C*	*D*	*E*	*F*
Year	*Current Annual Sales*	*CARB Ramp-up % Required*	*CARB Required EV Sales "Ramp up"*	*Based on Flat Demand Per Anderson (2024)*	*Based on Flat Demand Deficit/ Surplus to CARB Req (E-D)*
2026	1,800,000	35.00%	630,000.00	450,000	(180,000.00)
2027	1,800,000	43.00%	774,000.00	450,000	(324,000.00)
2028	1,800,000	49.50%	891,000.00	450,000	(441,000.00)
2029	1,800,000	59.00%	1,062,000.00	450,000	(612,000.00)
2030	1,800,000	68.10%	1,225,800.00	450,000	(775,800.00)
2031	1,800,000	76.00%	1,368,000.00	450,000	(918,000.00)
2032	1,800,000	82.00%	1,476,000.00	450,000	(1,026,000.00)
2033	1,800,000	88.00%	1,584,000.00	450,000	(1,134,000.00)
2034	1,800,000	94.00%	1,692,000.00	450,000	(1,242,000.00)
2035	1,800,000	100.00%	1,800,000.00	450,000	(1,350,000.00)
		Totals ------->	12,502,800.00	4,500,000.00	(8,002,800.00)

Sources: CARB (2022), Clegern & Young (2022), Anderson (2024)

3.2 National (US) Sales and Consumer Demand Data

Currently, less than 6% of Americans own electric vehicles. Most Americans still prefer to buy gasoline powered cars or if they are looking for an alternative, they favor hybrids over all-electric (Sherk & Sagert, 2023). While the cost to charge is relatively less than a tank of gas, the overall cost to purchase an electric vehicle is substantially more. One study found that 1/5 of all electric car owners in California returned to gas-powered because of convenience (Sherk & Sagert, 2023). Despite this criticism, as reported in Bloomberg, Randall (2023) states all-electric sales in the US were increasing dramatically between 2011 and 2023, taking ten years to reach its first one million in sales (2021) but only two years more (2023) to attain three million. California and Tesla are cited as the primary contributors for EV sales with California accounting for 39% of all sales and Tesla accounting for 61% through 2023 (Randall, 2023). According to Hickey (2024), US automobile dealers are concerned about inventory issues, particularly considering Tesla's historic dominance, although this company's market share dropped to 61% in 2023 from 80% in 2022. Competition includes new entrants such as the Volkswagen ID.4 at 3.4%, Chevrolet Bolt EUV at 2.8%, and Ford Mustang Mach-E, at 2.9%. Hickey (2024) further reports a decline in EV sales of 15.2% during the last quarter of 2023, as compared to the last quarter of 2022, and a decline of 2.2%, as compared to the first quarter of 2023. This data may negate a continued positive trend line.

Gallup (Jones, 2024) published poll results on April 8, 2024, that largely substantiate the somewhat flat to downward trend in EV marketplace acceptance as follows. Noteworthy, however, are the Gallups' findings from US residents (Table 7) regarding climate change and how those potential concerns affect future demand for EVs. An interesting finding from this survey is that even among those who "are very worried" about climate change a third would not buy. The largest percentage that would not buy are households making less than $40,000 per year, and results from all households, regardless of income or climate change concerns, indicate an increase in "would not buy" from 41% in 2023 to 48% in 2024. It is fair to note that these graphs represent national trends and are not broken out by state, and it would be entirely possible that California would skew more in favor of EV purchases. Furthermore, the preferences among national households (which include California) shift throughout time periods and are likely influenced by government subsidies, EV purchase prices, and both charging time and driving range capacity which appear to be improving due to enhanced technologies.

Table 7: Summary of Gallup Findings Regarding Electric Vehicle Ownership

	Currently Own	*Seriously Consider Buying*	*Might Buy in Future*	*Would Not Buy*	*No Response*
All Households:					
2023	4%	12%	43%	41%	0%
2024	7%	9%	35%	48%	1%
By Annual Household Inc:					
$100K+	14%	11%	34%	41%	0%
$40K - $99,999		9%	40%	44%	7%
Less than $40K		7%	29%	61%	3%
Concern About Climate Change					
Very Worried	8%	14%	43%	32%	3%
Somewhat	9%	8%	39%	42%	2%
Little or Not at All			23%	68%	9%

*Note: Largest percentage of "Would not buy" for "Lower Income" segment. *Source:* Jones, 2024

Shifting to supportive infrastructure and concerns, some industry experts question the ability to support the desired growth in EVs (IER, 2023). At current rates and even with $7.5 billion in funding from the federal Inflation Reduction Act (IRA), there is still a shortage of millions of available charging stations. If the needed ramp up of charging stations were to occur, the expansion would likely create an increased burden on the current electrical grid so upgrades will have to be made there as wel[1] (IER, 2023).

The overall takeaway is that the appetite for the adoption of EV is, in general, not close to unanimous or strong across all socioeconomic levels. The next section focuses on data, programs, and issues generated by California sources or matters generally applicable to California only.

3.3 Range Anxiety

Early in the advance of the electric vehicle market, Sovacool and Hirsch (2009) reported on various factors that inhibit the spread and acceptance of battery electric vehicles. Of paramount concern was range anxiety, which is defined by Neubauer and Wood (2014) as a negative sensation related to a combination of insufficient battery range capacity and limited charging station availability. As a result, range discussed in the literature becomes a major obstacle to EV market acceptance. More recent information supports the continued applicability of range anxiety. Mazda North American Operations (2025) provides similar definitions as previously indicated and describes three top conditions that cause it:

1. EV range – the belief that electric vehicles have limited driving ranges (Mazda somewhat refutes this concern by stating that range typically exceeds the daily round-trip commute).
2. Concerns about charging times and infrastructure – even if a driver gets to a charging station before the battery runs out of "charge", he may be worried about the amount of time it takes to charge the battery.
3. Lack of familiarity with charging stations and charging mechanics – new EV drivers encounter a learning curve that necessitates a certain amount of education to become more comfortable with the charging station experience.

Mildner (2023) also postulated three reasons for range anxiety that largely mirror those of Mazda North American Operations:

1. EV driving range is not sufficient – related to daily average commuting distances. Mildner echoes the Mazda assertion that charged battery capacity is generally sufficient – up to two

charges per week are usually adequate for US commuters and only one charge per week for Europeans.

2. Lack of public infrastructure -- To help alleviate range anxiety, the adequacy of public chargers is paramount since many commuters/drivers cannot charge at home or at the workplace. "Consumers increasingly expect the same services, simplicity and autonomy for EVs as they do for conventional vehicles (Mildner, 2023, para. 7).
3. Lack of public fast charging – Mildner concludes there is insufficient fast charging infrastructure across longer distance motorways.

As a result of the literature and ancillary information, these authors conclude that range anxiety in the adoption of EV market acceptance is a real and present phenomenon. The following is more detailed information regarding charging station availability in California and EV charging capacity:

3.3.1 Electric Vehicle Charging Stations – Concerns Across All Socio-Economic Levels

A significant issue relative to the 2035 Original Mandate is the availability and logistics of electric vehicle charging stations. Lopez (2022) determined that for every 10 new EV registrations, 1.5 charging stations need to be added.

Table 8: Electric Vehicle Chargers in California

Year	*Increase*	*Cumulative*
2019	41,947	41,947
2020	28,532	70,479
2021	8,544	79,023
2022	8,684	87,707
2023	17,305	105,012
Audit Adjust		105,012
Correction	35,554	140,566
2024	37,983	178,549

Source: California Energy Commission, 2024
Notes: For periods prior to 2024, per an audit adjustment, the amounts were understated by a cumulative total of 35,554. This error/adjustment skews reliable trend analyses.

Currently, public charging stations are largely located in urban areas, principally along the western area of the State near the coastline. Updated data from the California Energy Commission, as of August 26, 2024, indicates there are 178,549 charging stations in place, of which 84,271 are public and 94,278 are private. However, we can project the number of necessary charging stations to accommodate the Lopez (2022) estimate of 1.5 new charging stations for every 10 new EV's registered:

1. Per table 7, based on these authors' projected new EV sales from 2026 to 2035 of 450,000 per year, there will need to be 675,000 new charging stations in place (4,500,000 x .15).
2. Per table 7, based on the CARB ramp-up, if successful, there would have needed to be 1,875,420 charging stations in place (12,502,800 x .15).

If 37,983 newly added charging stations held constant until 2035, there would only be 379,830 new stations (37,983 x 10 years), falling far short of the necessary amounts per either of these authors projected new EV sales activity or the sales if the CARB ramp-up schedule materialized. Lusk et al. (2023) performed a quantitative study of low-to-moderate income consumer preferences for EVs on a national basis, as related to the availability of charging stations. Their findings indicate that upward of 90% of respondents would buy or lease an EV if the government subsidized the installation of charging stations at their residence or place of work. The timing of any such governmental endeavors and legislative support remains unknown currently.

Building more charging infrastructure in rural areas is also salient as residents tend to drive significantly more miles than commuters in areas with more infill. The types of automobiles likely used by rural drivers will require long-range charging capabilities (Lopez, 2022). How the state, private residences, and the private sector will fare in advancing the charging station infrastructure is unknown.

Given the recent California legislative and federal policy setbacks regarding the Mandate and flat to decreasing consumer demand for EVs, there does not appear to be any compelling evidence to suggest that substantial progress will be made in building an adequate charging station infrastructure in the near future.

3.3.2 BEVs - Range, Charging Time, Charging Cost, Battery Life, and Replacement CostBEV Range

Per Edmunds (n.d.) driving range is of utmost importance to potential EV drivers. This salient concern also involves a significant aforementioned lack of EV charging stations, particularly when compared to the abundance of gasoline stations. Many newer EVs have a driving range over 200 miles, and some, like the Lucid Air Grand Touring, can go in excess of 500 miles. At the lower end of range capacity, for example, the Nissan Leaf S has only a 149 mile range and the Chevrolet Volt is limited to 249 miles. There are many "higher-end" EVs and electric pick-up trucks that have ranges of 300 miles or slightly greater, such as the Ford Mustang Mach-E, the Ford F-150 Lightening, the Tesla Model X, and the Mercedes Benz EQS SUV.

3.3.3 Charging Time

"How long an electric car battery takes to charge depends on its size, the speed of the charger that's being used, and the battery's state of charge when the vehicle is plugged in" (Edmunds, n.d., para. 8). Most EV owners charge their vehicles at home and typically install a 240-volt level 2 home charger which charges more rapidly than, for instance, the 120-volt level 1 outlet. "The Chevy Bolt EV only gains 4 miles of range in an hour using a 120-volt outlet" (Edmunds, n.d., para. 9). Owners can get away with that speed if they don't drive much on a daily basis and always have their EV plugged in while parked. But if the battery is almost drained after a long trip, it can take over two days to fully charge it (Edmunds, n.d.). The level 3 charger is the fastest but is only available at public charging stations. For instance, if charged at such infrastructure, the Chevy Volt can be fully charged in 1.5 hours versus approximately two days with a 120-volt (Edmunds, n.d.).

3.3.4 Charging Cost

Most EV owners charge their vehicles at home, utilizing off-peak electric grid hours to minimize costs. Knowing the kWh charges from the applicable utility company certainly aids cost-effective planning. For example, at 20 cents per kWh, the Chevy Volt level 1 at-home cost approximates $13 to charge its battery pack (Edmunds, n.d.). Pre-calculation of likely costs, using a level 2 or level 3 charging station at a public site, is challenging, however. This is due to varying costs per station and the charging time per BEV. For example, the Audi Ioniq 5 takes approximately one hour to charge. At 37 cents per minute, it would cost approximately $22 if charged for a full hour. At 25 cents per minute, it would drop to approximately $15 and at 50 cents per minute, the cost would go to $30 (Edmunds, n.d.).

3.3.5 Battery Life

Electric car batteries last significantly longer than lithium batteries found in smaller electronic devices (Edmunds, n.d.). The U.S. Department of Energy states modern electric car batteries last twelve to fifteen years in milder climates and eight to twelve years in more extreme climates. Many experts espouse these batteries may perform for up to 20 years or 200,000 miles. Electric car battery warranties are typically strong, and "the federal government requires at least an eight-year/100,000-mile warranty on electric car batteries. California requires manufacturers to provide a longer 10-year/150,000-mile battery warranty (Edmunds, n.d., para. 17).

3.3.6 Battery Replacement Cost

"According to Consumer Reports, the replacement cost for an electric car battery ranges from $5,000 to $15,000, which is similar to the replacement cost of an engine" (Edmunds, n.d., para. 18). This

assumes the battery is not otherwise covered by a warranty. In certain instances, only certain components in the battery pack will have to be replaced, thus lowering the costs.

3.4 Potential California Pivot Point from a Push to a Pull Strategy in Pursuit of Environmental Goals

Arguably California's "Zero Emissions Vehicle Mandate" has entered challenging times. There are two primary facets of the Mandate:

1. Electric vehicle truck mandate for 2036
2. Electric vehicle (generally passenger cars) mandate for 2035

As reported by the online California Globe (Symon, 2025), following years of legal battles, a coalition of States led by Nebraska has successfully influenced California to repeal the "Advanced Clean Fleet" electric vehicle truck mandate for 2036. A May 2025 update on the California Air Resources Board (Symon, 2025) states the following:

> California has withdrawn its request for a waiver and authorization for the addition of the Advanced Clean Fleets (ACF) Regulation to its emissions control program. At this time, CARB is evaluating next steps. CARB is not enforcing the existing portions of the ACF Regulation that require a federal waiver or authorization, such as the portions of the ACF Regulation that apply to high priority and drayage fleets. However, not all elements of the ACF Regulation require a federal waiver or authorization. The state and local government fleets portion of the ACF Regulation remains unaffected. Because CARB is committed to reducing air pollution to protect public health, we encourage affected industries to continue reducing their emissions and we look forward to continued partnership in these efforts (CARB, 2025c).

Subsequently, the Wall Street Journal reported on a United States Senate vote not to grant a waiver for California's stricter car standards (stricter than National Standards), effectively killing California's EV 2035 mandate (Wise & Terlep, 2025). For clarification purposes, there are two separate issues in play. The revocation of emissions waivers by the US Senate applies to all types of vehicles. Within those "types" are trucks (pickups, delivery, etc.). California withdrew the waiver request for trucks, as indicated above, but did not withdraw the request for other vehicle types (generally, passenger cars). While these potential setbacks could be looked upon as tethered to the current administration and therefore only temporary, perhaps, given the size and nature of the cultural, political, legal and demographic shifts, a moment exists for California to rethink its' basic EV strategy.

In 1966, Elliott Lee wrote "A Theory of Migration" and introduced the concepts of Push and Pull Effects to describe the main drivers of human migration. Soon these concepts made their way into the Business discipline and were being applied as diametric Business Strategies in logistics and supply chain management. Finally, in 1967, Philip Kotler (2012) considered by many to be the father of modern-day marketing, as part of his writing on the four P's framework (Product, Price, Place, Promotion) included a discussion of Push versus Pull Strategies in Marketing (Kotler & Keller, 2005).

In the business world today, Push Strategies posit that you make something (a good or a service or a policy) and push it out to target customers and consumers for adoption. Pull Strategies posit that you understand what the target customers and consumers need, and then you fill those needs to create natural demand. Not unexpectedly, something that is "Pushed" upon someone tends to create "Pushback", whereas, filling a natural need tends to lead to a pulling in and adoption of something and therefore higher levels of acceptance. California's choice of words in describing their basic environmental strategy, up to now, "Mandate", reveals the Push Strategy it has been using. But what if a Pull Strategy was used instead? What would that look like and what could California focus on that would be more of a Pull than a Push?

This paper has shown that range anxiety is a major and arguably limiting factor in the adoption of EVs regardless of demographics. In addition, this paper has shown that California charging station availability and deployment is currently inadequate, and given that current plans are not likely to be addressed. Also, if charging stations were available, serious investigations of the capacity and stability of the California electrical grid strongly suggest the energy required to power such an increased electricity demand would not be clean, stable, or sufficient.

This suggests a potential policy strategy shift from Push to Pull would be for California to drop the Mandate/Push strategy and refocus its efforts on a Pull build out of the electric generation and electric grid, and charging station strategy. Not only would range anxiety be addressed, but concerns over

quantity and availability of electricity would be alleviated, something that could have tangible benefits in wildfire reduction and therefore positive environmental impact. Furthermore, serious consideration must be given to significant improvement in addressing the unaffordability of EVs for low-to-moderate income households. The pull strategy, as related to EV subsidies addressing affordability, must realistically address the following:

> It is common knowledge that California has incurred significant budget shortfalls in recent years, including effective abandonment of the Clean Vehicle Rebate Project (CARB, 2025a). The new combined program with the Clean Cars 4 All Program contains onerous income qualifications also requiring the "turning-in" of a pre-2007 gas-guzzling vehicle, and no data is available from the State identifying participation rates in 2024 or 2025. A review of the CARB 2024 Climate Investments Annual Report (CARB, 2024, pp. 66 – 75) reflects a cumulative total of $1.046 billion in project awards for the Clean Vehicle Rebate Project, an increase of $15 million (or 1.5%) over the 2023 Annual Report (CARB, 2024). The 2024 Clean Cars 4 All Program indicates cumulative awards amounting to $202 million (CARB, 2024), an increase of $25 million over the 2023 report. However, the data in the Climate Change Investments Annual Reports is six to twelve months behind, and the CARB has not reported any new activity in the combined program, effective November 8, 2023 and beyond, when the Clean Vehicle Rebate Project was closed (CARB, 2025d).

It is puzzling, yet potentially encouraging from a Pull strategy, that California has not allocated more funds for EV subsidies since the Cap-and-Trade Program is the primary funding source as indicated in the Climate Change Investments Annual Reports. When combining 2024 cumulative awards for both the Clean Vehicle Rebate Project and Clean Cars 4 All, amounting to $1.248 billion, and comparing this sum to cumulative awards for all projects of $13.913 billion, the percentage allocated to EV purchase incentives amounts to only 8.97%. The discretionary cap-and-trade pool is set at 40% as directed by legislation (MTC, 2025), and the aforementioned EV incentive programs are part of this pool. Because vehicle and semi-truck diesel emissions account for 39% of all carbon emissions in California (CARB, 2025e), the largest of seven categories of carbon emitters, the lack of greater EV subsidy allocations appears troubling, but potentially could create significant increases in allocations in the future.

At current annual cap-and-trade funding levels of approximately $2.2 billion (CARB, 2023, 2024), the discretionary 40% portion amounts to roughly $880 million per annum. To date, in the non-discretionary category, cumulatively since program inception, $4.4 billion has been awarded to affordable housing and $6.5 billion to the High-Speed-Rail Project (approximating the 30% requisite funding of roughly $22 billion in cumulative funding) (CARB, 2024). Neither of these categories demonstrates significant carbon reductions when compared to other categories, and the controversial High-Speed-Rail (HSR) has yet to be completed (Bikerton, 2025). The California legislature has the authority to amend cap-and-trade allocation percentages and could even increase the non-discretionary portion to accommodate even greater awards for EV purchase incentives/subsidies (MTC, 2025). However, pursuant to legislation signed by Governor Newsom on 19 September 2025, the cap-and-trade program has been extended to 2045 (Kuang & Mihalovich, 2025), which theoretically could provide more funding for EV and charging stations' subsidies. Perhaps complicating any future funding of such subsidies is recent legislation that guarantees $1 billion per year for ongoing HSR funding (California High Speed Rail Authority, 2025). It is not known how this annual obligation will impact any future EV and charging stations' subsidies in light of other competing projects, but considering that the HSR was previously receiving 30% of cap-and-trade revenues, an increase to roughly 50% ($1 billion/$2.2 billion) would seemingly impair funding for other projects.

In effect, it appears that California policy makers tout mandatory EV sales/use and have theoretically had access to significant resources to match policy with practice. Reasons for the inadequate historical subsidies are both puzzling and unknown, but one must question the political will to shift more funds to encourage greater EV sales among populations with not only affordability challenges but higher income households as well. These authors could not locate any evidence of cost-benefit analyses related to the various programs/projects funded by cap-and-trade. Again, the Legislative Analyst Office criticized CARB for not having any mechanism for measuring carbon reductions for the funded projects (LAO, 2024).

4. CONCLUSIONS

4.1 Research Question 1

Does an analysis of current data and trends suggest California would have been able to achieve 100% compliance with the "Original Mandate" for brand new zero emissions auto sales by 2035 (this assumes new EV sales only would replace 1.8 annual sales for all fuel types)?

Based on the analysis provided in this paper it is improbable that California would have achieved 100% compliance with the "Original Mandate". The secondary data and literature show less than robust demand for zero-emissions vehicles by citizens at both the National level and more importantly at the State level within California.

Digging more deeply into what is likely to be a driver of the shortfall is an analysis showing that California incentives focused on low-income California Households (those making less than $75,000 per year), while well intentioned, were not likely enough to encourage these low-income socio-economic groups to appreciably participate. This demographic makes up 40% of the 13,699,816 households in California, per Table 6, and their lack of participation severely attenuated implementation in all likelihood.

4.2 Research Question 2

Based on current trends and ancillary data, can California develop enough charging stations to facilitate desired purchase demand for brand new zero emissions EV's?

The analysis provided in this paper shows that under either of two scenarios, CARB's (2022) implied pseudo-exponential EV ramp up to a 2035 total of over 12 million new EVs in service, or a straight-line increase in EV's as posited by data from Anderson[19], in-service charging stations fall short of needs. As the current distribution of charging stations is very West Coast centric, the lack of charging stations in the inland and more mountainous sections of California likely adds to consumer concerns around range anxiety. In addition, the lower socio-economic households performing more so-called blue collar manual jobs and services will find the lack of charging stations even more problematic.

4.3 Recommendation

As discussed by Push-Pull Theory, California should drop the Mandate/Push strategy and refocus its' efforts on a Pull build out of the electric generation and electric grid and charging station strategy, as well as allocating all future cap-and-trade funds (discretionary and non-discretionary) to EV purchase incentives/subsidies, as well as charging station financial assistance for low-to-moderate income households. Not only would range anxiety (the limited number of miles that can be driven by an EV battery charge) be addressed but concerns over quantity and availability of electricity would be alleviated, something that could have tangible benefits in wildfire reduction and therefore have a positive environmental impact.

Addressing significant development of charging stations must include outreach to, and cooperation with, local government stakeholders, such as counties and cities, as well as business organizations such as local chambers of commerce and the Building Industry Association. Enlargement of the stakeholder pool is essential as California has extremely diverse factors that influence charging station construction, such as racial and cultural diversity, income disparities, geographical differences and extremes, vast differences between rural and urban populations/areas, and political differences.

Regarding EV affordability, even if the discretionary 40% pool were strictly allocated to EV purchase incentives, with no adjustments to the non-discretionary funding, it appears that endeavor would quadruple cumulative funding to date in just five years.

4.4 Areas for Further Research

The following points are worth noting to evolve the future research:

1. Extensive research, quantitative and qualitative, is necessary in low-income communities to assess factors related to their acceptance of EVs, as well as how a government subsidized charging station would influence their decision to buy a new EV.
2. In addition, this research needs to determine the affordability of new EVs and what monthly payment is necessary to facilitate EV purchases in these communities.
3. Beyond low-income communities, research is needed for all income groups as some evidence suggests EV demand is leveling and even reducing in some groups.
4. Targeted technical research is necessary to evaluate the installation of charging stations in multi-family apartments where many low-income households reside. Further complicating the installations is the well-known common knowledge factor of excessive street parking in these communities. Because of the high cost of rent, apartments often contain more than one household, but most adult occupants typically have a vehicle. The number of parking spaces in the apartment complexes is usually inadequate.
5. In addressing necessary charging station development, the use of Geospatial Analysis (GIS) to visually map infrastructure gaps and Time-Series and Machine Learning models would be beneficial to further explore the consumer behaviors and infrastructure gaps.

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AUTHORS' DECLARATIONS AND ESSENTIAL ETHICAL COMPLIANCES

Authors' Contributions (in accordance with ICMJE criteria for authorship)

Contribution	*Author 1*	*Author 2*	*Author 3*	*Author 4*
Conceived and designed the research or analysis	Yes	Yes	Yes	Yes
Collected the data	Yes	No	No	No
Contributed to data analysis & interpretation	Yes	Yes	Yes	Yes
Wrote the article/paper	Yes	No	No	No
Critical revision of the article/paper	Yes	Yes	Yes	Yes
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